HR-286 Development of a Rational Characterization Method for Iowa fly Ash

Key Words: Fly ash, Ettringite, Fly ash paste, Compressive strength

ABSTRACT

Iowa coal fired power plants currently produce over 350,000 tons of high calcium (ASTM Class C) fly ash each year. Most of the plants are of modern design and burn low sulfur, sub-bituminous coal from the Powder River Basin near Gillette, Wyoming. The ashes produced from these plants are self-cementitious and exhibit 28-day paste compressive strengths ranging from 500 to 7000 psi. Past research had indicated that the paste strength of ash from a given power plant was highly variable over time. Standard ASTM test data of these same ashes, however, did not indicate any obvious differences in the ash being produced. This research project was conducted in an attempt to determine the cause of the paste strength variability and to develop test methods to more adequately reflect fly ash physical and chemical characteristics.

An extensive 3 year sampling and testing program was developed and initiated which incorporated fly ash from several Iowa power plants. Power plant design and operating data were collected. Results of ASTM physical and chemical testing show little variation with time, irrespective of fly ash source. Part of the reason for this is directly attributable to the ASTM composite method of sampling which tends to mask actual variability. The ASTM available alkali test underestimates the amount of alkalis that can be released from Iowa high-calcium fly ashes. Fly ash paste strength and other physical properties can change dramatically within short periods of time. This variability is directly linked to power plant maintenance schedules and to sodium carbonate coal pretreatment. Fly ash physical and chemical properties can change drastically immediately before and after a maintenance outage. The concentrations of sulfate bearing minerals in the fly ash increases sharply during shutdown. Chemical, mineralogical, and physical testing indicated that the sodium, sulfate bearing minerals, lime and tricalcium aluminate contents of the fly ashes play important roles in the development of hydration reaction products in fly ash pastes. The weak pastes always contained ettringite as the major reaction product. The strong pastes contained straetlingite and monosulfoaluminate as the major reaction products along with minor amounts of ettringite. Recommendations for testing procedure changes and suggested interim test methods are presented in the report.